Vol. 23. Parts 7–9. pp. 67–85. 15th September, 1948

THE PROCEEDINGS

OF THE

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON

Series A.

GENERAL ENTOMOLOGY

World List abbreviation : *Proc. R. ent. Soc. Lond.* (*A*)

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LONDON

PUBLISHED BY THE SOCIETY AND

SOLD AT ITS ROOMS, 41, QUEEN'S GATE, S.W.7

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MOUTHPARTS AND FEEDING HABITS OF BLEPHAROCERIDAE (DIPTERA).

By M. G. M. Pryor, Ph.D.

The mouthparts of Blepharoceridae are interesting because they are like those of the Mecoptera, yet the way in which they are used suggests how more specialized types may have arisen. They have not been described in detail before, except for figures of whole heads by Bischoff and Komarek and a description of the maxilla and labium of *Edwardsina gracilis* by Imms (1944). The following descriptions are based on material of *Liponeura cinerascens* Bischoff and *Blepharocera fasciata* Westwood, both dried and fixed in formalin. The *Liponeura* were collected at Savica in the Slovenian Alps, and the *Blepharocera* at Tardets (Basses Pyrénées).

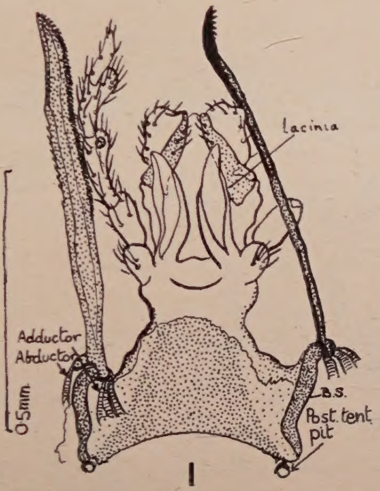

Fig. 1.—Labium and mandibles of a female *Blepharocera fasciata*. Viewed from the front. The right mandible is twisted out of its natural plane, and the laciniae are not in the natural position. B.S., basal sclerite.

The mandibles of female *Blepharocera* are long and narrow, with pointed tips and sharp teeth projecting backwards along the inner edge. They articulate by single condyles with two basal sclerites (B.S., fig. 1), which run backwards to the posterior tentorial pits. They are moved by large adductor and much smaller abductor muscles attached by short tendons to their base. The mandibles of *Liponeura* are similar but longer.

The labrum of both species is like a beak, arched to form a channel, which is closed behind by the hypopharynx. The hypopharynx has teeth on both sides pointing forwards, and has the duct of the salivary gland opening near the tip. The fore-gut is heavily sclerotized, and the dilator muscles forming the cibarial pump can be seen running between its dorsal wall and the clypeus.

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The labium of both species ends in two fleshy palps, which appear to be connected in the mid-line by a slightly folded membrane. The palps are moved by three pairs of muscles as described by Imms (*l.c.*) for *Edwardsina* ; the flexors and extensors of the first joint (f_1 ; ext_1, fig. 2B), and the flexors of the second joint (f_2). The terminal lobes are bulkier than those of *Edwardsina*, and their shape suggests that of typical labella. In *Liponeura* the first joint of the palps is produced on the inner corners of its posterior face into two sclerotised hinges (S.H., fig. 2A), which suggests that the palp can be bent backwards like the labellum of a blowfly. The labium of *Liponeura* is longer than that of *Blepharocera*, but in both the base of the prementum articulates with the posterior pits (fig. 1). The labium can be retracted by flexure of the prementum on its basal attachment. The sides of the groove between the two palps on the anterior face of the labium are supported by two curved rod-like sclerites (R.S., fig. 2A).

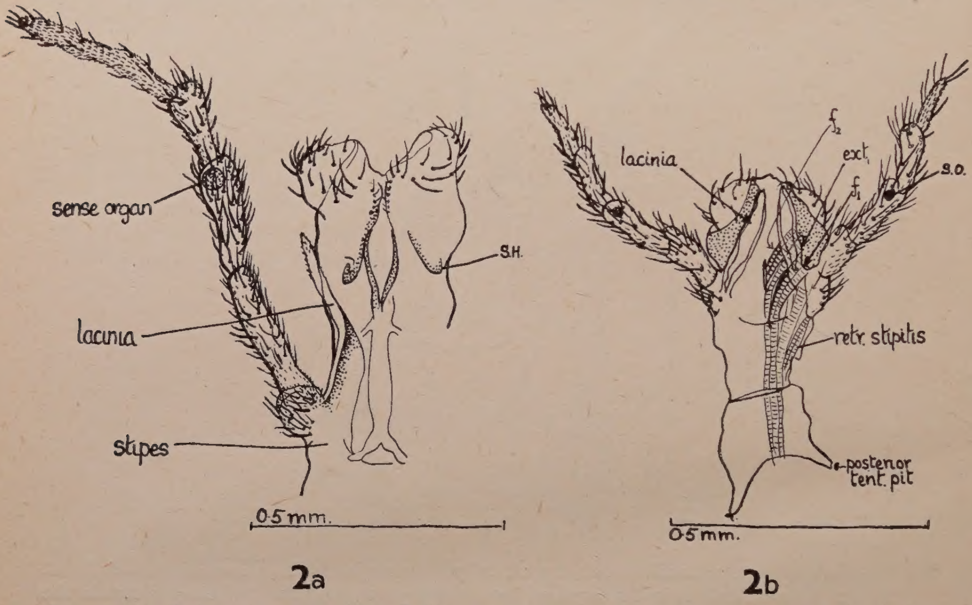

FIG. 2.—A. Labium and maxilla of *Liponeura cinerascens* (female). The lacinia is displaced from its natural position. R.S., Rod-like sclerite holding open labial groove ; S.H., sclerotised hinge. B. Labium of *Blepharocera fasciata* (female). Lacinia in natural position. S.O., Sense organ ; f_1, flexor of first joint of labial palp ; f_2, ext_2 flexors and extensors of second joint.

The maxillae are reduced to 5-jointed palps and slender laciniae arising from a small stipes ; there is no trace of a cardo. On the third joint of the palp is a sense organ of the kind described by Imms (*l.c.*) in *Edwardsina*. The lacinia of *Blepharocera* is shaped like a rabbit's ear, and fits into the groove on the anterior face of the labium ; it is very nearly the same shape as that of *Nannochorista*, which is carried in a similar position. The lacinia of *Liponeura* starts as a deep channel, but a short way from the base it is bent through a

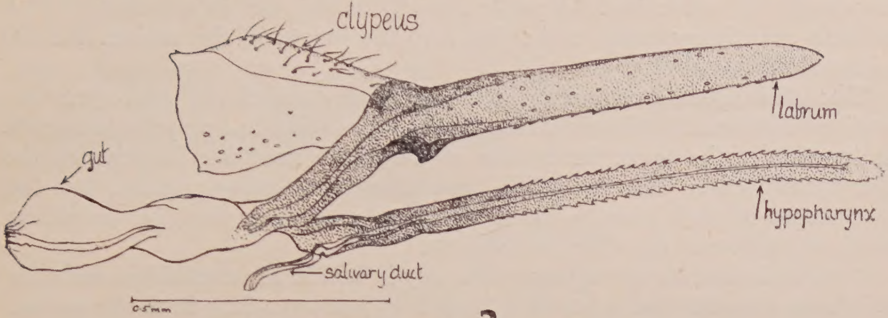

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FIG. 3.—Labrum and hypopharynx of *Liponeura cinerascens* (female).

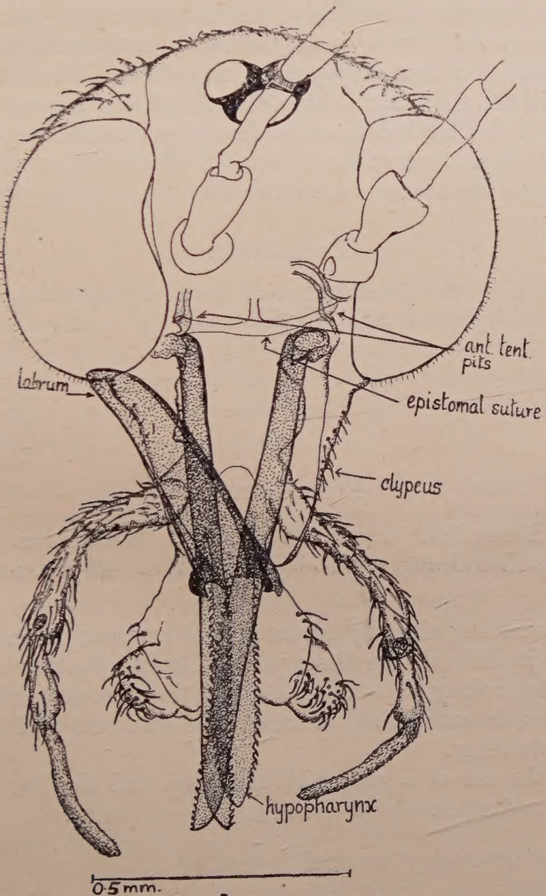

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FIG. 4.—Whole head of female *Liponeura cinerascens*. From a cleared specimen. The labrum raised to show the position of the parts beneath.

§

sharp angle, the sclerotised side walls come to an end, and it is prolonged as a flat strip with hairy edges, which fits into the groove of the labium like the lacinia of *Blepharocera*.

When the mandibles are brought together, they and the hypopharynx can be gripped between the terminal lobes of the labial palps in a way that suggests the function of the tip of the labium of the female mosquito in gripping the other mouthparts. The tips of the mandibles are sharply pointed, but the arrangement of their muscles shows that they cannot, in fact, be moved up and down relative to the other mouthparts.

From their structure it appears that prey is held in the mandibles, and that the labium and other parts are used to suck up juices exuding from the wound. The teeth on the hypopharynx may be used to inflict more wounds, but it is difficult to see how it could be moved relative to the labrum.

Females of *Blepharocera* were common at Tardets in August. They frequent thickets near the river where they breed, and spend most of their time hanging head downwards from the underside of leaves; the upper pair of eyes, which are only present in the female, point vertically downwards in this position, and probably serve to detect prey passing underneath. I never saw a female catch anything in the field, but a female confined in a large glass-topped pill-box caught hold of another female across the abdomen and hung on tenaciously; seen through a lens practically the whole width of the victim's abdomen seemed to be held between her captor's mandibles.

REFERENCE.

IMMS. A. D., 1944, On the Constitution of the Maxillae and Labium in Mecoptera and Diptera. *Q. J. M. Sci.* **85**: 73.

BOOK NOTICE.

The Spell of the Honey Bee. By W. E. KELSEY. 2nd edition. 8vo. London (Chapman & Hall, Ltd.), 1947. Pp. xii + 274. 49 pls., text illust. Price 18s. 6d.

This book is written primarily for small bee-keepers, in an easy conversational style. It is divided into three parts, the first dealing with the annual cycle of life of a bee colony, the second covering the seasonal work of the apiary, and such matters as extracting, enemies and diseases, and the third with pollination and anatomy.

The photographs are of a very high standard and the book also contains good working drawings to assist the amateur craftsman.

THE BIOLOGY OF PARASITES OF *LOXOSTEGE STICTICALIS* L. IN NORTH AMERICA. IV: *CRYPTUS INORNATUS* PRATT (ICHNEUMONIDAE, CRYPTINAE).

By F. J. Simmonds.

(*Imperial Parasite Service.*)

Introduction.

The species under consideration here is the only parasite so far reared in the present investigations from *Loxostege sticticalis* L. that actually attacks the host whilst it is in the cocoon, apart from a single record of a second, so far unidentified, species of *Cryptus*. Although reared in 1941 and 1942, it was not possible to give it a specific name until 1945, when a monograph on Nearctic Cryptinae was published by Pratt (1945).

It was not common in hibernating *Loxostege* material in 1941 or 1942, but was comparatively so in 1945. Although it appears to have an extended distribution, at least in so far as Montana and Alberta are concerned, there are no previous host records for this species (Simmonds, 1947), and its biology has not been previously investigated.

Systematic Position.

This species belongs to the extensive and widespread Ichneumonid subfamily Cryptinae and to the tribe Cryptini, the characters of which have been thoroughly dealt with by Pratt (1945), who also gives a key to the Nearctic genera and a lengthy discussion of the status of the Ichneumonid genus *Cryptus* Fabricius, which is actually a homonym of the Tenthredinid genus *Cryptus* Panzer. The following are synonyms :

Cryptus Fabricius = *Merinopus* Foerster (Tschek.) = *Itamoplex* Foerster (Ashmead) = *Hedycryptus* Cameron = *Steriphocryptus* Cameron = *Synechocryptus* Schmiedeknecht.

Pratt gives a key to the North American species of *Cryptus*, together with descriptions of a number of new species, amongst which the present species is found. *Cryptus inornatus* Pratt is similar to *C. albitarsis* (Cresson), but according to Pratt, is distinct " in simply arched second recurrent vein, and in several characters of the head." From material examined here it would appear that the second recurrent vein of *inornatus* may also be somewhat curved.

General Biology.

The life-history of *Cryptus inornatus* is very similar to that of *Cryptus sexannulatus* Gravenhorst, a European parasite of spin-ups of the codling moth, *Cydia pomonella* L., and one that was introduced into Canada from France in 1940 (Rosenberg, 1934 ; Naphthali, 1941 ; and Simmonds, 1944) in an attempt at the biological control of this pest.

In overwintering *Loxostege* material collected in Montana and Alberta

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Cryptus was present in the form of cocoons within the spin-ups of the host. These cocoons contained full-grown larvae, some of which continued their development when brought into a higher temperature in the laboratory and emerged in a short time ; others were in a true state of diapause. This difference in overwintering parasite larvae has been noted before in *Ephialtes caudatus* Ratzeburg, another European parasite of *Cydia pomonella* (Simmonds, 1944), where some full-grown larvae remained in diapause after prolonged exposure to high temperature, while others continued their development, apparently hibernating, not in diapause, but in a state of inactivity induced by temperatures below the threshold of development. This character gives the species a very flexible seasonal cycle. Warm weather in the autumn causes the emergence of numbers of *Cryptus*, and the females are thus given further opportunity of attacking the hibernating host larvae. Also, in the spring, the parasite larvae not in diapause give rise to adults emerging early, which may attack the hibernating host larvae before these have pupated. Larvae in a true state of diapause ensure that the species will be present in the following spring, even if during the winter fluctuating conditions occur which might cause further development of the other type of overwintering larva and subsequent death of the adults in the cold weather. This possibility of a dual or treble attack on the hibernating host larvae increases the controlling action of the species.

Whether from directly developing material or from larvae in diapause, the behaviour of the adults on emergence is similar. Freshly emerged females and males that have been kept segregated from females for several days mate readily, although it was often found to be impossible to obtain mating with females several days old. In both the field and laboratory, males emerge somewhat earlier (approximately one day) than the females, thus producing a condition conducive to successful mating. The preliminary actions of the male and final act of copulation are without peculiarities, and are similar to those of many Ichneumonids. Mating is not an essential preliminary to oviposition, unfertilized eggs producing male progeny. In the field males seem to predominate somewhat in all collections. From one batch of host cocoons 158 male and 91 female *Cryptus* were reared, giving 36·5 per cent. females. Some females lay no eggs, and it was found on dissection that these have often brown deposits of wound chitin in some part of the reproductive system, indicating that a traumatic condition is sometimes responsible for this sterility.

Extensive mass-rearing and experimental work has been done with this species, particularly in regard to factors affecting diapause, and the results will be published later, though a brief preliminary account of part of the work has already been given (Simmonds, 1946). From these investigations a number of the biological characteristics of *Cryptus inornatus* have been obtained and are given below.

From the results of the investigations of diapause, it may be briefly stated here that there is no definite generation the larvae of which enter diapause, but that this state is brought about by environmental conditions that tend to lower the general rate of metabolism, conditions acting not only during larval development, but also during the development of eggs within the female. These developing eggs are affected by physiological conditions prevailing within the ovaries, which in their turn are affected by the age and diet of the parent female.

Female *Cryptus* searching for hosts in the field have been observed running over the soil of beet fields where infestations of *Loxostege* have occurred, and where a number of cocoons of the host are present near the base of the beet plants. These females examine and enter cracks in the parched soil where host cocoons may be sufficiently exposed for successful attack. Females have also been observed ovipositing in the laboratory. Exposed cocoons of *Loxostege* are carefully examined for a long while by the female, whose antennae are bent sharply downwards about the middle and the tips tapped incessantly on the walls of the spin-ups. After going to and fro along the cocoon a number of times, the position of the larva within is apparently determined, and the female thrusts her ovipositor through the soil-covered cocoon into the host. After possibly several thrusts, during which time the host larva may endeavour to escape to the other end of the cocoon, it is eventually stung and killed. In this condition the host larva may remain for a lengthy period without desiccation or decomposition. When a larva has been stung oviposition may or may not take place ; when this does occur the ovipositor is thrust into the cocoon and an egg laid within the cocoon near to the host larva. Superparasitism is common, several eggs often being laid in the same cocoon, although only one larva can reach maturity on a single host and the supernumerary individuals are killed. This superparasitism occurs even when hosts are plentiful, and at the same time a number of hosts are killed but no eggs laid on them. This, obviously, causes a waste of parasite eggs, and indicates that the instinct of the female for regulating her oviposition so as to produce an efficient distribution of her eggs is far from perfect. Along with viable eggs females may also lay a small proportion of non-viable " collapsed " eggs, which lack the essentials for further development. This has been noted before with *Ephialtes caudatus* and *Cryptus sexannulatus* (Rosenberg, 1934 ; Simmonds, 1944, etc.). These collapsed eggs were found to be more common with females fed on raisin than those fed on sugar, and it seems as though nutrient material was then sufficiently plentiful to allow of the production of more numerous ova, some of which, because of the pressure of more developing eggs, had to be laid when only imperfectly formed.

LABORATORY PROPAGATION.

Owing to the nature of its attack on *Loxostege* it was felt that this species might prove a useful adjunct to the parasite complex of *Loxostege frustalis* Zeller in South Africa. Hence an effort was made to evolve a suitable technique for mass-breeding in the laboratory and to obtain numbers of parasites for shipment.

In experimental work using isolated females, five host spin-ups were placed with each female daily. Loss of eggs due to the superparasitism mentioned above was avoided by careful dissection and examination of the host cocoons the day after oviposition occurred. Eggs were placed singly by means of a camel-hair brush on individual stung hosts in small shell vials. If there were more eggs than hosts, these were placed on larvae that had been killed by coddling them in hot water at 120°F. for two minutes. Cotton-wool plugs were placed in these vials and pushed down so as to enclose the host larva and parasite egg in a small space. This reduced mortality in later stages by preventing the parasite larvae wandering far from the hosts, and reducing the possibility of desiccation. These vials were examined daily, and any host larvae that had dried up or decomposed were replaced with fresh ones. When the parasite larvae were nearly full-grown both parasite and host were placed in a small gelatin capsule, where development of the larva was concluded and a cocoon formed. In these capsules the cocoons could be handled and shipped more easily than when they were formed in glass vials.

In mass-breeding a large number (50–100) of females that had been individually mated as described above were placed in a large (14″ × 10″ × 10″) wooden-framed cage with top, back and sides of cheesecloth and sliding celluloid front. Raisins and cotton-wood soaked in water were provided ; a number of *Loxostege* spin-ups were placed in the cage, and after being exposed to attack for 24 hours they were changed. At first comparatively few cocoons were used and heavy superparasitism occurred. This did not matter, since the cocoons were dissected and examined on removal from the cage and the parasite eggs placed individually in vials with coddled hosts as described above. However, the labour involved in this operation was considerable. Since hosts and parasites were plentiful it was decided to eliminate this handling even at the cost of losing a proportion of the hosts and of the parasite eggs due to stinging without oviposition and to superparasitism. For this purpose a larger number of cocoons was placed daily in each cage, the number being regulated by examination of samples of cocoons to determine the optimum number of hosts per cage which would reduce waste of hosts and parasite eggs to a minimum. These cocoons were removed daily from the cages after being exposed to parasitism, and were left at 75° F. for six days, by which time those that had been parasitized contained nearly full-grown parasite larvae. The host cocoons were then dissected, and parasite larvae and their hosts were placed as before individually in gelatin capsules, where they formed cocoons and were ready for shipment without further handling.

DESCRIPTION OF THE IMMATURE STAGES.

a. *The Egg.*

As stated above, the egg is laid loose in the host cocoon beside the dead host larva. It is comparatively large (fig. 1), and is usually very elongately ovoid in shape, though this may vary considerably. It is usually somewhat narrower at one end than the other, and is approximately 1·5–2·0 mm. in length and ·3–·5 mm. in greatest width. In colour it is translucent white at either end with a smaller or larger central area of a yellowish colour, the intensity of which is also variable. The surface of the chorion is smooth.

The eggs hatch in from 1 to 2 days at 75° F.

b. *First Stage Larva.*

The first stage larva leaves the egg by forming a split at the anterior end and then squeezing out, leaving the flattened chorion. The larva immediately begins to feed ectoparasitically on the host larva. The mandibles pierce the skin of the host and the parasite feeds on the body fluids. The larva at this point is about 2·0 mm. long and about ·45 mm. across the broadest part, about half-way down the body (fig. 2). The head-capsule possesses a pair of prominent antennae, and is without further outstanding characters (fig. 3). The tracheal system is well developed and there are 9 pairs of spiracles. The skin is covered with small simple spines.

The first stage lasts about 24 hours.

c. *Second, Third and Fourth Stages.*

These are similar to one another except in size; growth is rapid, each stage lasting approximately one day. The skin remains spiny and the spiracles become more prominent. The most obvious change apart from size is seen in the head-capsules, two of which are shown in figs. 4 and 5. Here there is apparent a reduction in the comparative size of the antennae, an increase in chitinization of the head struts, and increase in numbers of the facial sensoria.

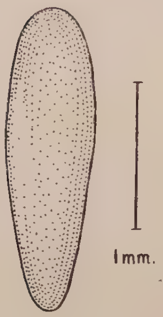
d. *Fifth Stage Larva.*

The full-grown larva (fig. 6) is of the usual Ichneumonid type, fleshy and grub-like. The chitinization of the head-capsule is distinct and is shown in fig. 7. An abdominal spiracle is shown in fig. 8, and a portion of the skin from the dorsal part of the abdomen in fig. 9. The larva in this last stage devours the host entirely, leaving the dry larval skin. It then spins a cocoon, the total larval feeding period having lasted at 75° F. approximately 5 days.

e. *Cocoon, Prepupa and Pupa.*

The cocoon is cylindrical with rounded ends about ·9–1·3 cm. in length and ·4 cm. in width, its size being dependent on that of the full-grown larva, regulated in turn by the amount of food available during growth. The cocoon is formed within that of the host, and is of fairly fine consistency, though there may be a number of coarse fibres on the outside. When freshly spun it is transparent white in colour, but darkens slowly, and in field collected material is usually dark brown or black. Unlike the case of *Sphecophaga burra* (Cresson), there is no correlation between cocoon colour and the condition of the enclosed larva with respect to diapause (Schmieder, 1939).

Within the cocoon the larva may continue its development, or at this stage may enter a state of diapause. In the latter event, conditions apparently favourable for continued development do not result in pupa formation; the larva remains as such for an extended period before further development ensues. This period of diapause is passed more easily at a low temperature when there is a lower mortality than when such larvae are kept at room temperatures. This state of diapause is not necessary for successful overwintering, full-grown larvae being able to withstand winter conditions with a simple cessation of development caused by temperatures below the threshold of development. With direct development, or when diapause is broken, the larva forms a prepupa (fig. 10), a stage lasting 1–2 days, and giving rise to the pupa (fig. 11). This is at first yellowish white, but darkens gradually to the colours of the adult before emergence some 5–6 days later.



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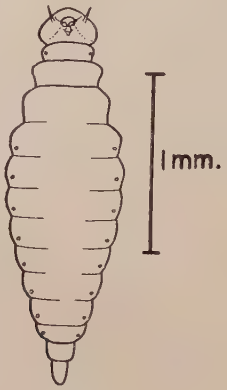

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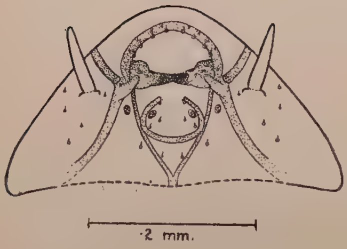

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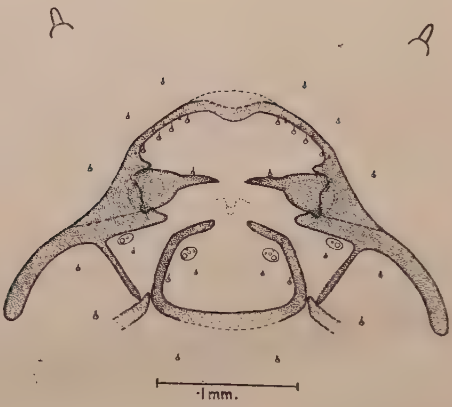

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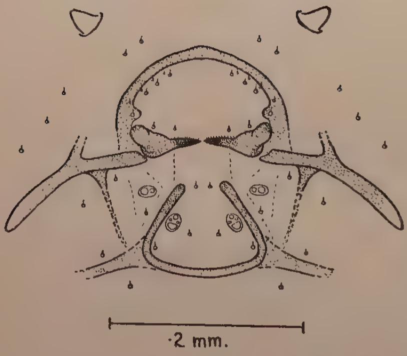

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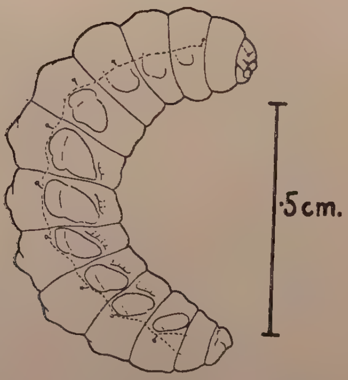

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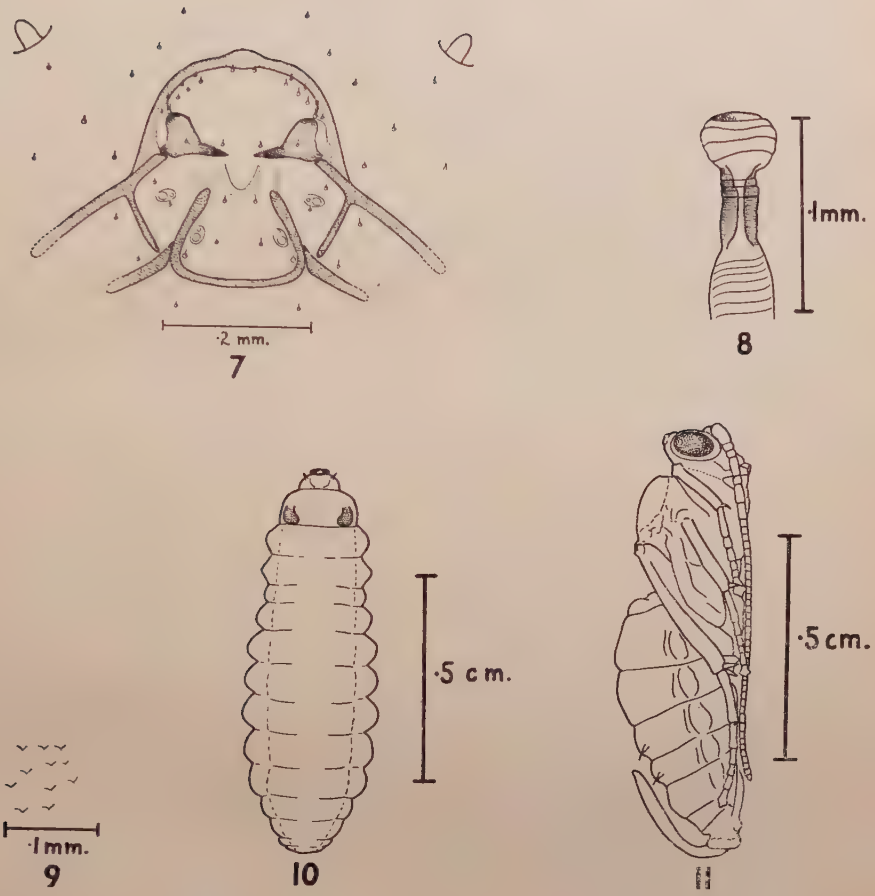

FIGS. 1–11.—*Cryptus inornatus* Pratt. (1) Egg. (2) Freshly hatched 1st stage larva. (3) 1st stage larva; head capsule. (4) 3rd stage larva; head capsule. (5) 4th stage larva; head capsule. (6) Full grown larva. (7) Full grown larva; head capsule. (8) Full grown larva; abdominal spiracle. (9) Full grown larva; skin on dorsal part of abdomen. (10) Prepupa. (11) Male pupa.

TABLE I.—*Biological Characteristics of* Cryptus inornatus *Pratt at 75° F. Average of Ten Females in each of each Category.*

Food provided for female in addition to water and honey water.	Preoviposition period in days.	Postoviposition period in days.	Laying period in days.	Length of life of female.	Total eggs laid.	Mortality.	% Mortality.
Cane-sugar	3·4	21·2	13·9	38·5	27·1	9·2	30·6
Cane-sugar and raisin	1·1	16·0	29·0	46·1	90·7	43·6	48·1
Raisin	1·5	8·6	34·0	44·1	113·1	50·6	44·3

Food provided for female in addition to water and honey water.	No. of hosts attacked but not parasitized.	Progeny.			Larvae in diapause.	% Larvae in diapause.
		♂	♀	%♀♀		
Cane-sugar	11·0	13.7	3·7	38·4	·4	2·5
Cane-sugar and raisin	19·5	18·4	11·5	59·9	17·2	36·5
Raisin	11·2	30·5	13·7	46·4	18·3	29·0

IMPORTANCE.

It is probable that from a simple consideration of the degree of parasitism attained by *Cryptus* in overwintering host material collected in the early autumn, the importance of this species as a controlling agent may be underestimated. In 1941 from *Loxostege* material collected in Montana, only one male and two females of *Cryptus* emerged (·12 per cent. of the total material), and in 1942 from host spin-ups from Alberta three females emerged (·04 per cent. of the total material). In 1945 material from Alberta gave an average of 1·73 per cent. parasitism (15,000 host cocoons). However, these figures do not adequately represent the degree of destruction of the host effected by this species. When *Loxostege* spin-ups were being collected in 1945 *Cryptus* was still active in the field, so that further parasitism would have occurred had the spin-ups been left in the ground. Also, as mentioned above, *Cryptus* emerges in the spring some time before the host larvae begin to pupate, and can thus make a second attack on the same host larvae. This attack in the spring may occur after a number of the larval parasites have already emerged from the host and formed their cocoons, thus reducing the chance of multiparasitism. *Cryptus*, an ectoparasite, is extrinsically superior to the internal parasites, and any such avoidance of multi-parasitism is beneficial to the parasite complex in general. It has, too, been bred from hosts that have already produced a full-grown larva of *Meteorus loxostegei* Viereck. There has, however, been no indication that *Cryptus* females definitely avoid attacking larvae that have been already parasitized and contain immature stages of other species. With this ectoparasitic habit, too, *Cryptus* is free from attack by the secondaries *Perilampus similis* Crawford and *Mesochorus perniciosus* Viereck. Hence a special effort was made to ensure as far as possible the establishment of this species in South Africa, and with the mass-breeding method outlined above some 12,000 cocoons of *Cryptus* were shipped to provide both breeding stock and material for liberation in the field against *Loxostege frustralis* Zeller.

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BOOK NOTICES.

Fragments of Entomological History. Part II. By HERBERT OSBORN. 8vo. Columbus, Ohio (The Author), 1946. Pp. viii + 232, 36 plates. Price $2.75.

The first part of this work appeared in 1939, and the second part comprises additional records and portraits which bring the matter up to a later date. The second part is written in the same informal style as the first, and its historical value lies in the data on the origin and development of the publications and institutions on which the science has been built, and in the personal sketches of the entomologists associated with it.

Fichier entomologique chinois. Musée Heude, Shanghai, 1939–1941.

This serial consists entirely of beautiful coloured plates of Chinese insects, each in a separate folder, and accompanued by a reproduction of the original description of the insect, which in many cases appeared in the *Notes d'Entomologie chinoise.* There are at least ten, and sometimes more, plates per series. Five series have so far been published, comprising 59 plates, dealing with 48 species.

The first three series are hand coloured, and cost U.S. $25.00 each ; the last two are lithographed and cost U.S. $15.00 each.

THE ROTHAMSTED LIGHT TRAP.

By C. B. Williams, Sc.D.

(*Rothamsted Experimental Station, Harpenden*).

In 1923 I designed, for use particularly in the Egyptian Desert, a light trap for insects which had certain advantages over those previously known to me. A detailed drawing of this trap was reproduced in the *Rev. appl. Ent.* (A) **11** : 245. It was successful in catching large numbers of insects, and a further description with slight modifications was published in 1924.

In 1930 de Worms gave a brief account and photograph of a trap that he had constructed from these descriptions, and also gave a list of 144 species of Lepidoptera that he had captured in it in England during 1929.

In 1933 I made a trap of similar type and had it working in the fields at Rothamsted, about 25 miles north of London, for four years almost continuously, during which period about 850,000 insects were captured, of which about 87 per cent. were Diptera, and about 88,000 (11 per cent.) Lepidoptera. The 16,500 "Macrolepidoptera" which were identified included 240 species. This trap was briefly described and figured in 1935.

Since the war trapping has again been resumed, and in the two years 1946 and 1947 a total of approximately 7700 Macrolepidoptera has been caught in the same trap in the same position, and the total number of species raised from 240 to about 256.

During the three years 1945–1947 Messrs. J. and P. Bell, at Berkhamsted, have used a similar trap, and have caught in this period over 44,500 individuals of over 300 species of Macrolepidoptera.

The original trap in Egypt was arranged to burn acetylene ; the English models have all used electricity, and one was constructed for use in East Africa to burn kerosene (paraffin) vapour.

So the trap has been tested under varied conditions, and appears to give reliable and satisfactory results. Small modifications have been made at times, chiefly to simplify construction, and the following is an account of the various types now in use.

The general principle of the trap is a bright source of light surrounded by sheets of glass forming an outer slope which leads the insects towards the light, and an inner slope which leads them into the killing bottle. The trap is like a lighthouse and the light shows in all directions. Above is a roof to keep out the rain.

Fig. 1 shows a cross-section of the electric light trap, which is the easiest to work and to construct, and illustrates the relatively simple construction. The details, of course, have to be varied to suit illuminant and the size of killing bottle required and other local conditions.

The trap as constructed at Rothamsted (see Plate I) consists of a stout wood base about 22½ in. square, with a hole about 2 in. square in the centre leading to the killing bottle. Near each corner is a small round hole about ¼ in. diameter. About 10 in. above the base is a metal (or wood) top

PROC. R. ENT. SOC. LOND. (A) 23. PTS. 7–9 (SEPT., 1948).

to keep out the rain. In the centre of this is an opening about 3 in. square for the purpose of cleaning the trap and changing the electric light bulb. The edges of this are raised, and over it fits a loose lid with the edges bent down, the whole making a joint through which rain does not pass. The roof also has $\frac{1}{4}$-in. holes in each corner corresponding to those in the base. A metal rod, about $11\frac{1}{2}$ in. long and screwed for a short distance at each end, is put through each of these holes to hold the top and base together, and they are kept apart either by a length of metal tubing loosely fitting round the rod, or by a nut above and below the base and the roof. The killing bottle we use is a 2 lb. or 3-lb. fruit-bottling jar (Kilner or Forster type), which is sold with a glass stopper and an open metal screw top. One of the screw tops is fastened underneath the centre opening in the base, and the bottle can be fastened on by a couple of turns.

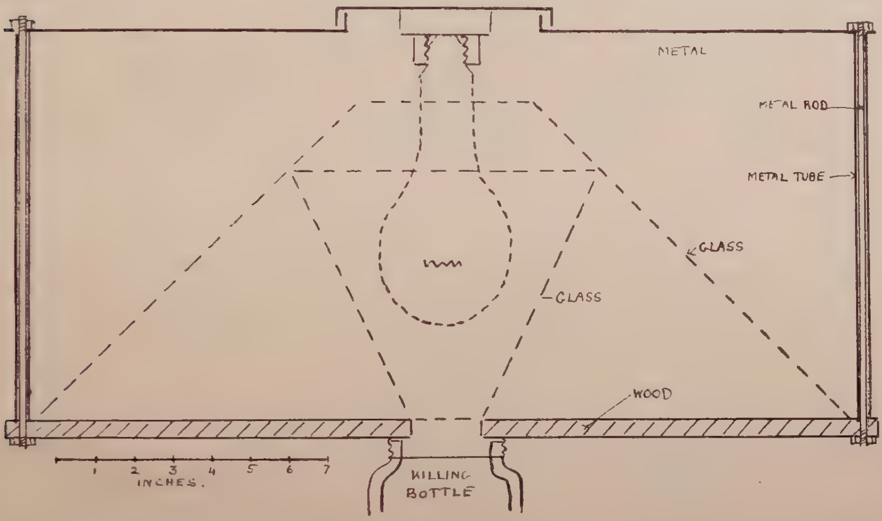
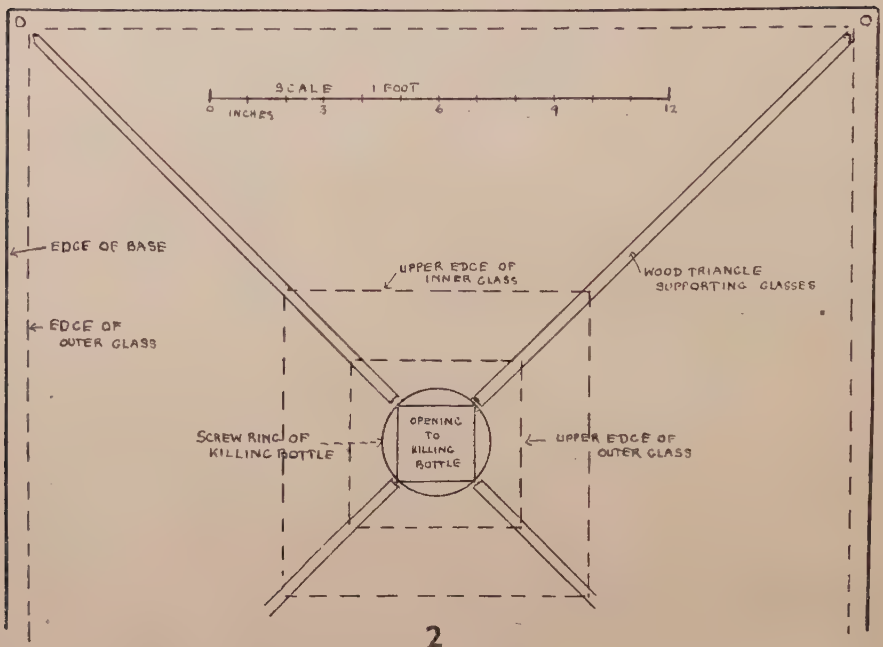


Fig. 1.—Cross-section of electric light trap.

All the metal and woodwork of the trap should be painted *black* to discourage the insects from settling.

The glass consists of eight pieces, four outer ones and four smaller inner ones as shown in figs. 2 and 3. The outer ones form a truncate square pyramid with its broad base in the base of the trap and coming to within about 2 in. of the top at the centre; the smaller ones form an inner square funnel leading down to the opening of the killing bottle.

Several methods of fitting these glasses have been tried. In one model (Plate 1 B) metal frames were made in which the glasses fit. This was excellent in use, but somewhat difficult to make except by a skilled workman. In another of our traps (Plate 1 A) the glasses are supported by wooden triangles radiating out from the corners of the opening to the killing bottle to the corners of the trap; on these first the inner glasses are laid and then the outer glasses.


SCALE 1 FOOT
0 INCHES 3 6 9 12
EDGE OF BASE
EDGE OF OUTER GLASS
UPPER EDGE OF INNER GLASS
WOOD TRIANGLE SUPPORTING GLASSES
SCREW RING OF KILLING BOTTLE
OPENING TO KILLING BOTTLE
UPPER EDGE OF OUTER GLASS

2

Fig. 2.—Plan of trap.

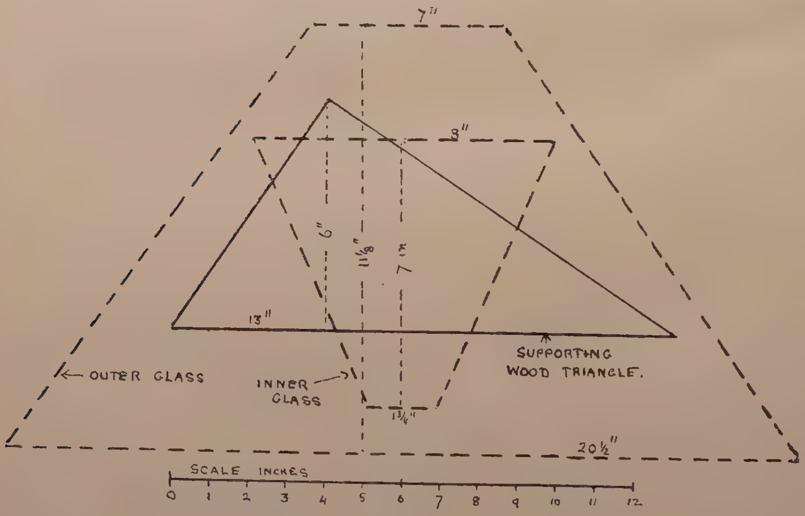


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Fig. 3.—Size of glass and wood triangles used in trap.

For permanent work the outer glasses are kept down by lengths of soft "compo" metal tubing, split and opened and then screwed down in two or three places between the glass. For temporary use the glasses can be held together by adhesive tape. If this is painted over with black varnish it will last for several months.

The illuminant we use is a 200 watt electric clear bulb with a screw fitting, and the socket is fitted to the square lid in the middle of the roof (fig. 1).

The trap can be placed on legs or on a tripod, or hung from wires from posts or from a tree.

Fig. 1 shows a cross-section of the trap, all glass being shown by dotted lines; fig. 2 shows a plan, and fig. 3 shows the size of the glasses and the wood triangles; and from these it should be possible to construct a trap quite similar to the ones in use at Rothamsted. It should be emphasized, however, that the general principles are of wide application and are very flexible.

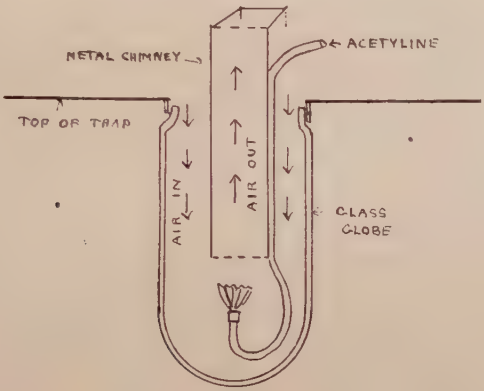

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Fig. 4.—Diagram of special burner used with acetylene light trap.

Anyone wishing to construct one not quite to these specifications should consider first the illuminant and the size of insects expected to be caught, and the probable numbers which determine the size of the killing bottle necessary.

Lighting.

Our trap uses a 200 watt bulb; a slightly smaller trap could be designed to take a 100 watt bulb, and we had in use for one year a larger model with a 500 watt bulb. Electricity has the very great advantage that it can be controlled by a time switch, which will turn on and off the trap at prearranged times.

The trap first constructed in Egypt used acetylene from a generator, and for this it was necessary to construct a special burner in a glass globe closed beneath (fig. 4), and with a chimney over the flame to obtain the necessary ventilation. This worked fairly well, but there was frequent trouble with carbon deposits on the burner. Compressed acetylene gas might be more satisfactory, but I have had no personal experience with it.

In 1934 I was asked to make a portable trap, using a paraffin (kerosene) vapour inverted mantle lamp for Dr. F. W. Edwards to take on a trip to East Africa. The one constructed is shown in Plate 1 (C), from which most details can be seen. The whole trap packed into the case, shown beneath. This worked satisfactorily from an entomological point of view, but it required some practice to overcome the vagaries of the pressure lamp, which on one occasion went out and flooded everything with oil.

Killing Bottle.

We use a 2- or 3-lb. fruit bottling jar, but for work in the tropics a much larger killing bottle would be desirable. Our trap has caught hawk-moths up to the size of the Privet Hawk (about 4½ in. across the wings), but if larger insects were expected the trap should be made larger, and with greater clearances round the light and a larger entrance to the killing bottle.

We have used various killing agents, including sodium, potassium and calcium cyanides, and carbon tetrachloride and carbon bisulphide; but at present we use only tetra-chlor-ethane, a comparatively cheap and not unpleasantly smelling volatile liquid which is sometimes used for fumigation of greenhouses against insect pests. It is very much safer than cyanide, does no damage to the colour of Lepidoptera, so far as we have discovered, and leaves the insects in a relaxed condition suitable for setting.

Tetra-chlor-ethane is obtainable from many large chemical dealers, such as British Drug Houses, London, N. 1; Messrs. Harrington Bros., London, E.C. 1; or Messrs. May & Baker, Dagenham. The present price is about two shillings and sixpence a pint.

One method of use is to place at the bottom of the killing bottle about 1½ in. of moist Plaster of Paris and allow this to set and dry out. When the killing bottle is required, about a teaspoonful of tetra-chlor-ethane is poured on to the plaster, into which it sinks, and the vapour is slowly given off.

A variant of this method, which has certain advantages but is not so simple to construct, is to put moist Plaster of Paris in the bottle and then to roll it slowly on its side until the plaster sets, so that the plaster forms a cylinder round the sides of the bottle. The advantage of this is that if you get a very large catch you get a better and more rapid kill, as the insects already in the bottle do not form a blanket over the plaster and prevent the diffusion of the vapour.

With our present killing bottle at least 90 per cent. of the Lepidoptera are in good condition, and at least 98 per cent. identifiable. The great danger is when one or two large beetles get into the bottle; for some reason these die slowly, and often spoil many of the other specimens by crawling around.

In a tropical country, where big catches and big insects were expected, it might be good to have a very large killing bottle with a net across the middle to allow the smaller insects to fall through.

One of my correspondents puts a thick layer of cotton-wool at the bottom of the bottle, and then several layers of stiff blotting-paper. This also appears to work satisfactorily.

In the trap used at Rothamsted from 1932 to 1937 we had eight killing bottles, each a 2-lb. honey jar, on a turn-table with a mechanism so that the bottles could be changed automatically at any pre-determined time of the night. This mechanism is illustrated in a plate in Williams, 1935. It gave very interesting information on the time of night at which different species of insects entered the trap.

The outside of any glass killing bottle must be, of course, painted with a black opaque paint or covered with a light-tight covering, as no light must escape under the trap.

I have thought of experimenting with "dry ice" (solid frozen carbon dioxide) as a killing agent: although it might be difficult to use, it would have the double effect of cold and CO_2 poisoning, and would, I feel sure, produce very rapid immobility. So far no opportunity has occurred to try it.

Another of my correspondents does not use a killing agent, but puts a large box beneath the trap, painted white on the inside. The insects settle on the walls and can be examined next morning. This has the great advantage of not killing any unnecessary insects, which would be particularly valuable if the trap were to be used in a specialized and restricted ecological area, but for accurate statistical work I doubt if it is reliable, and it is not possible later to check identifications.

On the question of destruction it might be pointed out that the trap probably catches nearly all species in proportion to their abundance. So that large numbers are only caught of common species. After four years continual trapping at Rothamsted we have no evidence that the trapping has made the slightest difference to the local abundance of any insect.

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EXPLANATION OF PLATE 1.

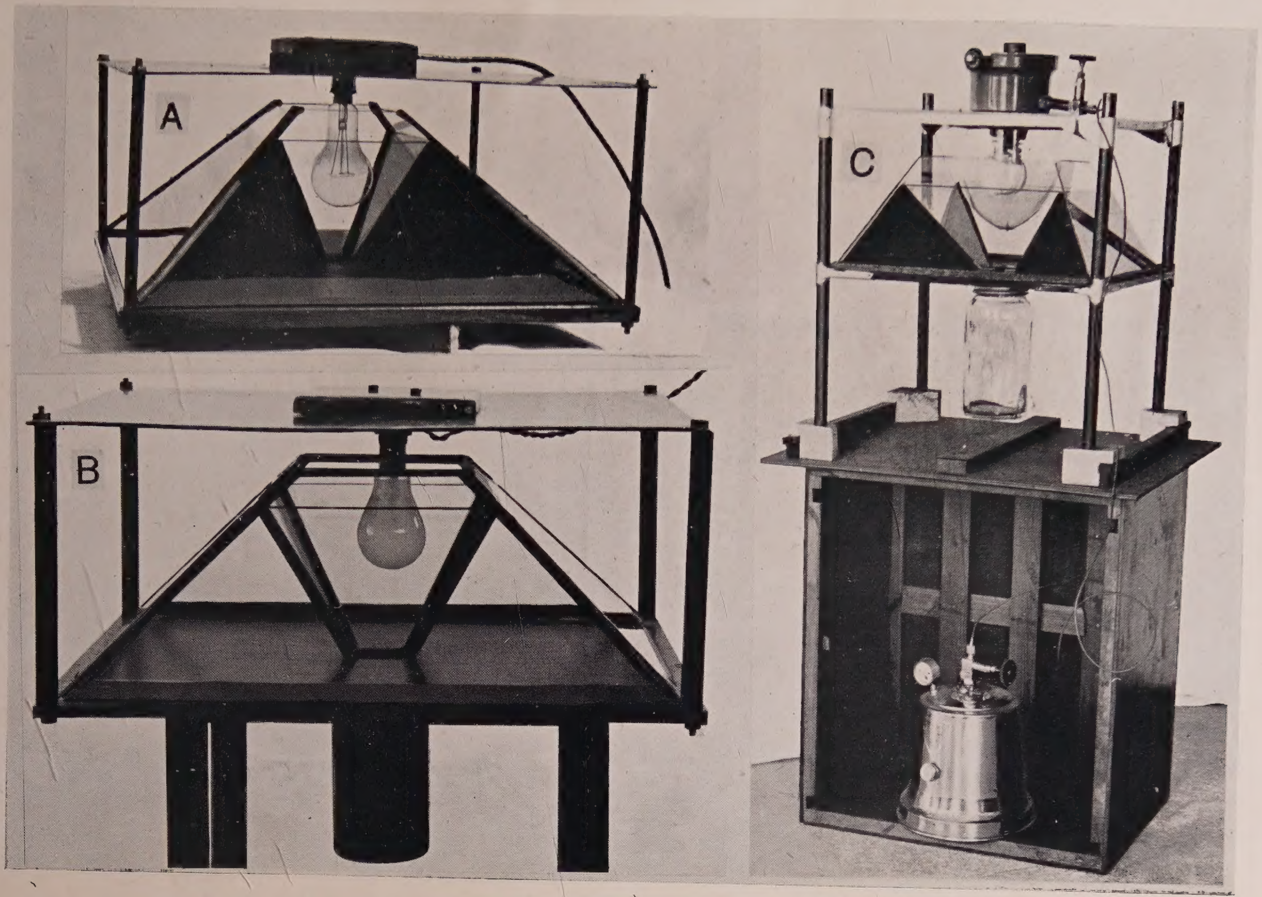
Three modifications of the Rothamsted Light Trap:

A. The sloping glasses supported on wooden triangles.

B. The glass supported by metal framework.

C. A portable model designed to burn paraffin vapour.

Plate 1.



C. B. Williams.

The Rothamsted Light Trap.

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TO BE HELD IN THE SOCIETY'S ROOMS

41, **Queen's Gate, S.W. 7**

1948

WEDNESDAY, October 6
,, November 3
,, December 1

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